Fishery Data Series No. 94-20

Abundance and Length Composition of Northern Pike Near the Confluence of the Pilgrim and Kuzitrin Rivers, 1992-1993

by

Alan Burkholder

August 1994

Alaska Department of Fish and Game

Division of Sport Fish

FISHERY DATA SERIES NO. 94-20

ABUNDANCE AND LENGTH COMPOSITION OF NORTHERN PIKE NEAR THE CONFLUENCE OF THE PILGRIM AND KUZITRIN RIVERS, 1992-1993[1]

By

Alan Burkholder

Alaska Department of Fish and Game
Division of Sport Fish
Anchorage, Alaska

August 1994

[1] This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-77K) under Projects F-10-8 and F-10-9, Study R, Job No. 3-4(c).

The Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Fishery Data Series reports are intended for fishery and other technical professionals. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This report summarizes three sampling events conducted during 1992 and 1993 for estimation of abundance of northern pike *Esox lucius* in the Pilgrim and Kuzitrin rivers, Seward Peninsula. There were an estimated 10,828 (SE = 2,019) northern pike (≥ 300 millimeters in fork length) in 1992 in the study area, which comprised the confluence of the Pilgrim and Kuzitrin rivers. No trophy size northern pike were captured. Those northern pike that were ≥ 300 millimeters in length were comprised of the following Relative Stock Density categories: 27% were "stock", 39% were "quality", 26% were "preferred", and 7% were "memorable". Only 7% of the 151 fish caught in 1992 and recaptured in 1993 were correctly aged as one year older. Due to the error in determining ages, the age composition of northern pike sampled in the Kuzitrin/Pilgrim study area was not estimated.

KEY WORDS: northern pike, *Esox lucius*, abundance, length composition, Pilgrim River, Kuzitrin River, Seward Peninsula.

INTRODUCTION

An estimated 1,194 northern pike *Esox lucius* were harvested from the Pilgrim River by the sport fishery in 1990, accounting for the second largest sport harvest of northern pike in Alaska during 1990 (Mills 1991). This estimated harvest was substantially higher than the previously reported estimated sport harvests of 147, 91, and 415 northern pike for 1983, 1988, and 1989, respectively (Figure 1; Mills 1984, 1989, and 1990). Since 1990 the reported sport fish harvests have decreased, with 608 and 231 northern pike harvested by this fishery in 1991 and 1992, respectively (Figure 1; Mills 1992 and 1993). Current regulations for the sport fishery are 10 northern pike per day, 10 in possession, no size limit, and no closed season.

In addition to the sport harvest there is a subsistence fishery for northern pike by the residents of Teller and Nome. No estimates of subsistence harvests are available. Limited anecdotal accounts suggest that the subsistence harvest of northern pike occurs primarily in the winter/spring by setting gill nets under the ice. No permit is required for subsistence fishing, and there is no bag limit for subsistence-caught northern pike.

Increased sport harvest in 1990 and limited background information on northern pike population abundance, structure, and dynamics coupled with the assumption that northern pike are susceptible to overharvest prompted the Department of Fish and Game (ADF&G) to conduct a stock assessment program for northern pike in the Pilgrim and Kuzitrin rivers in 1992 and 1993.

Objectives

The goal of this project was to assess the abundance and composition of northern pike in the lower Pilgrim River drainage. This report summarizes research conducted in 1992 and 1993 on the composition and abundance of northern pike in the Pilgrim and Kuzitrin rivers.

Project objectives were:

1. to estimate the population abundance of northern pike in the Pilgrim River;
2. to estimate the age and length compositions of northern pike in the Pilgrim River; and,
3. to test the hypothesis that the northern pike in the Pilgrim River are a geographically closed population.

Results from 1992 indicated that the immigration rate of northern pike from the Kuzitrin River into the Pilgrim River and vice versa exceeded 5% (Burkholder 1993), therefore since northern pike had been marked in both

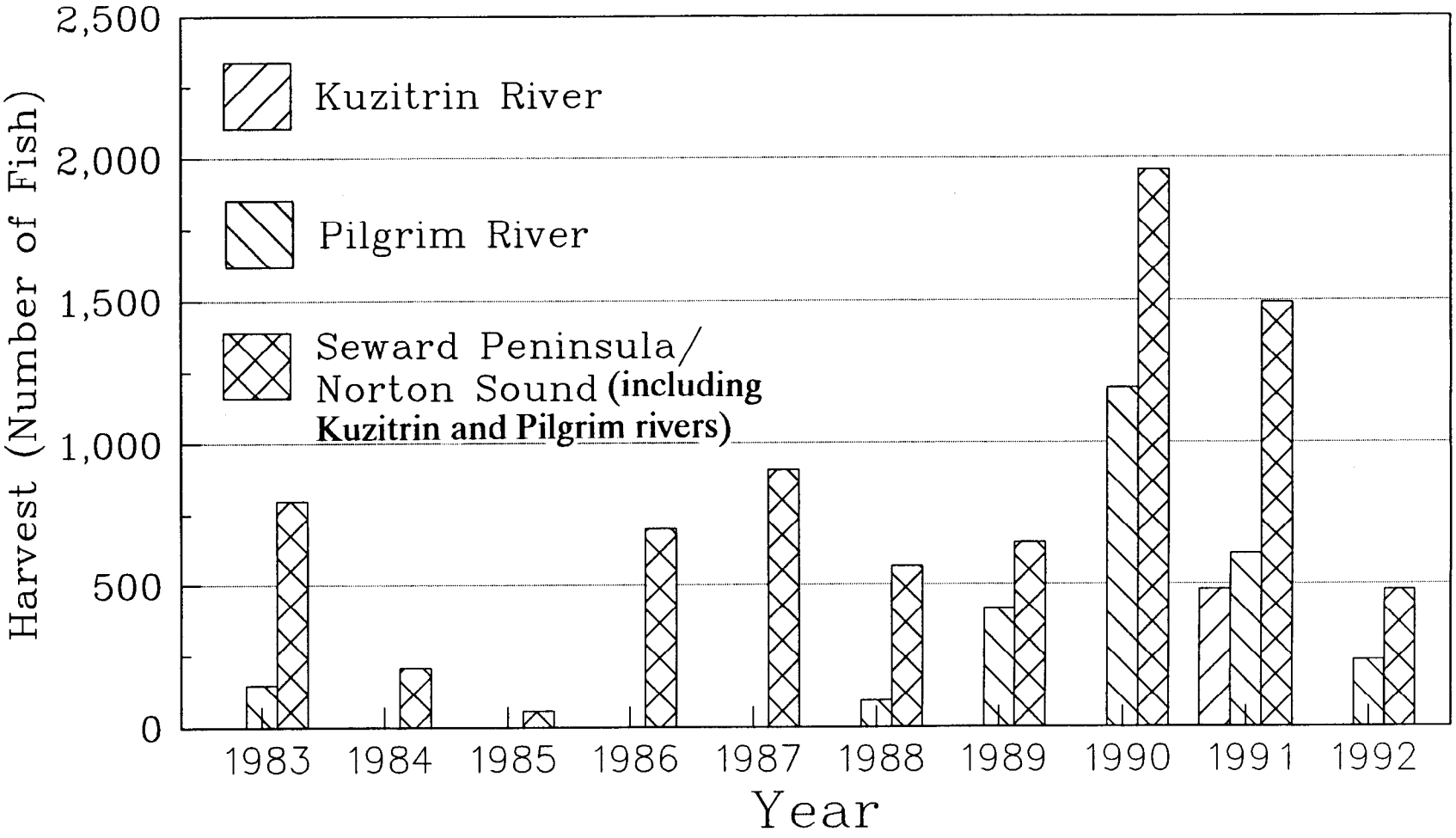

Figure 1. Estimated harvest of northern pike from the Kuzitrin River, Pilgrim River, and Seward Peninsula/Norton Sound, 1983-1992.

the Pilgrim and Kuzitrin rivers the abundance and composition objectives for 1993 were:

1. to estimate the abundance of northern pike in the Pilgrim\Kuzitrin study area; and,

2. to estimate the age and length compositions of northern pike in the Pilgrim\Kuzitrin study area.

Study Area

The Pilgrim and Kuzitrin rivers are located on the Seward Peninsula. The Pilgrim River originates in Salmon Lake and flows north and east for approximately 72 km before entering the Kuzitrin River (Figure 2). Access to these rivers is attained by aircraft, the Kougarok Road from Nome, or by boat from Teller via Imuruk Basin. The specific study area (Figure 3) was near the confluence of the Pilgrim and Kuzitrin rivers.

METHODS

Study Design

The study design consisted of a mark-recapture experiment based on three sampling events: 27 June to 3 July 1992; 7 July to 17 July 1992; and 17 June to June 28, 1993. The primary sampling gear during all events was hoop traps with wings and leads (Table 1). These traps were used to block off sloughs and entrances to lakes adjacent to the main river channels of both the Pilgrim and Kuzitrin rivers (Figure 3). During each event traps were fished continuously except for brief periods of time when they were moved from one location to another. Variable mesh gill nets (Table 1) were also fished in similar areas as well as in connected lakes and the main river channels during events one and two. Sampling was conducted by a two-person crew during the first two sampling events and a four person crew during the third event.

Data Collection

During all sampling events, northern pike were examined for marks; marked; and sampled for age and length. Captured northern pike were measured to the nearest 1 mm fork length (FL). During events one and two, unmarked northern pike greater than 299 mm FL judged to be in healthy condition were marked with a Floy FD-68 internal anchor tag inserted posteriorly at the left base of the dorsal fin and released. In addition, fish marked in the Pilgrim River received a partial left pectoral fin clip, and fish marked in the Kuzitrin River received a partial right pectoral fin clip. During event three, floy tags were not used. Fish marked in the Pilgrim River received a partial left pelvic fin clip, and fish marked in the Kuzitrin River received a partial right pelvic fin clip. Because determination of sex using external characteristics (Casselman 1974) was found to be unreliable, sex was recorded

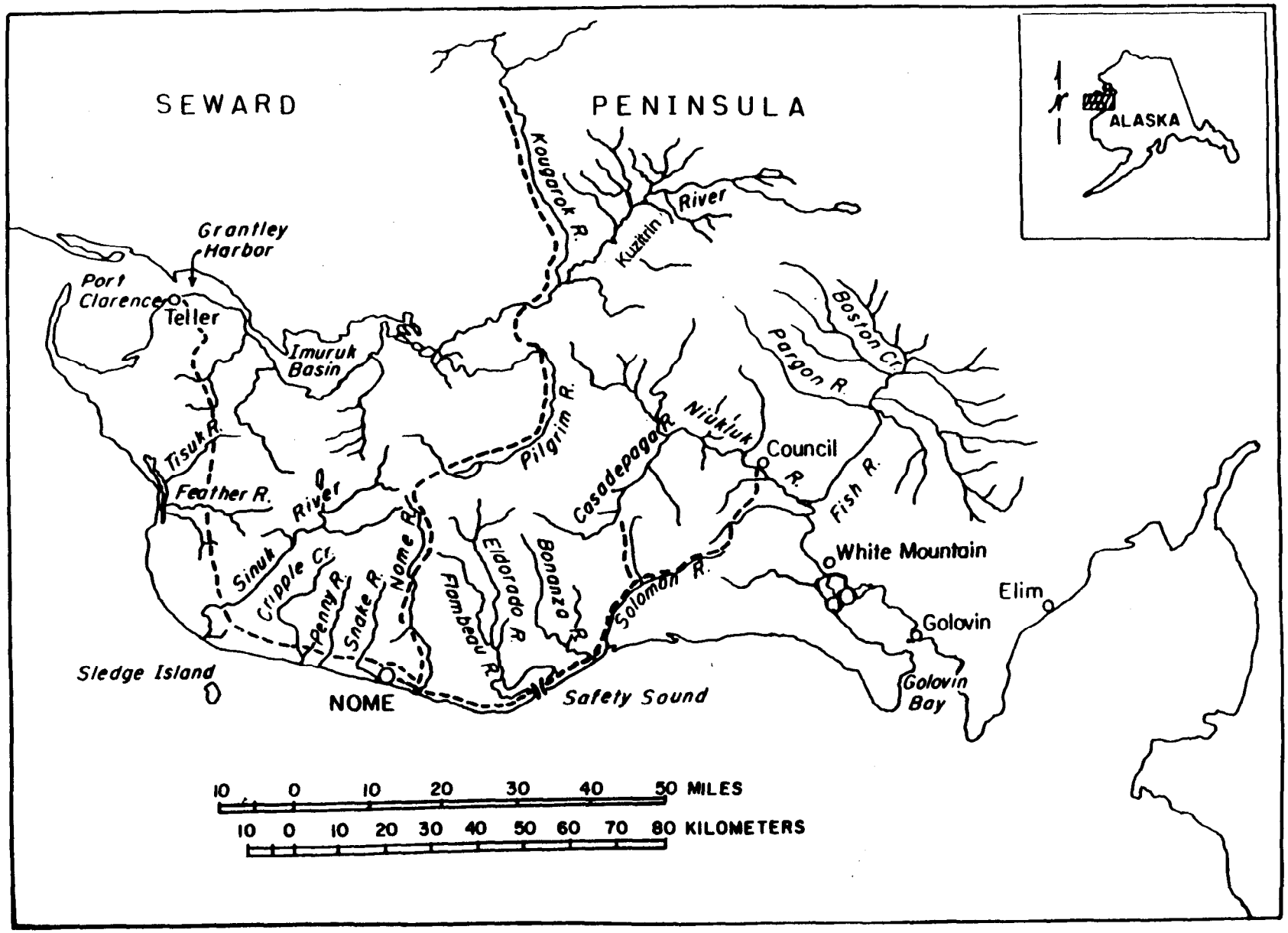

Figure 2. The location of the Pilgrim and Kuzitrin rivers on the Seward Peninsula.

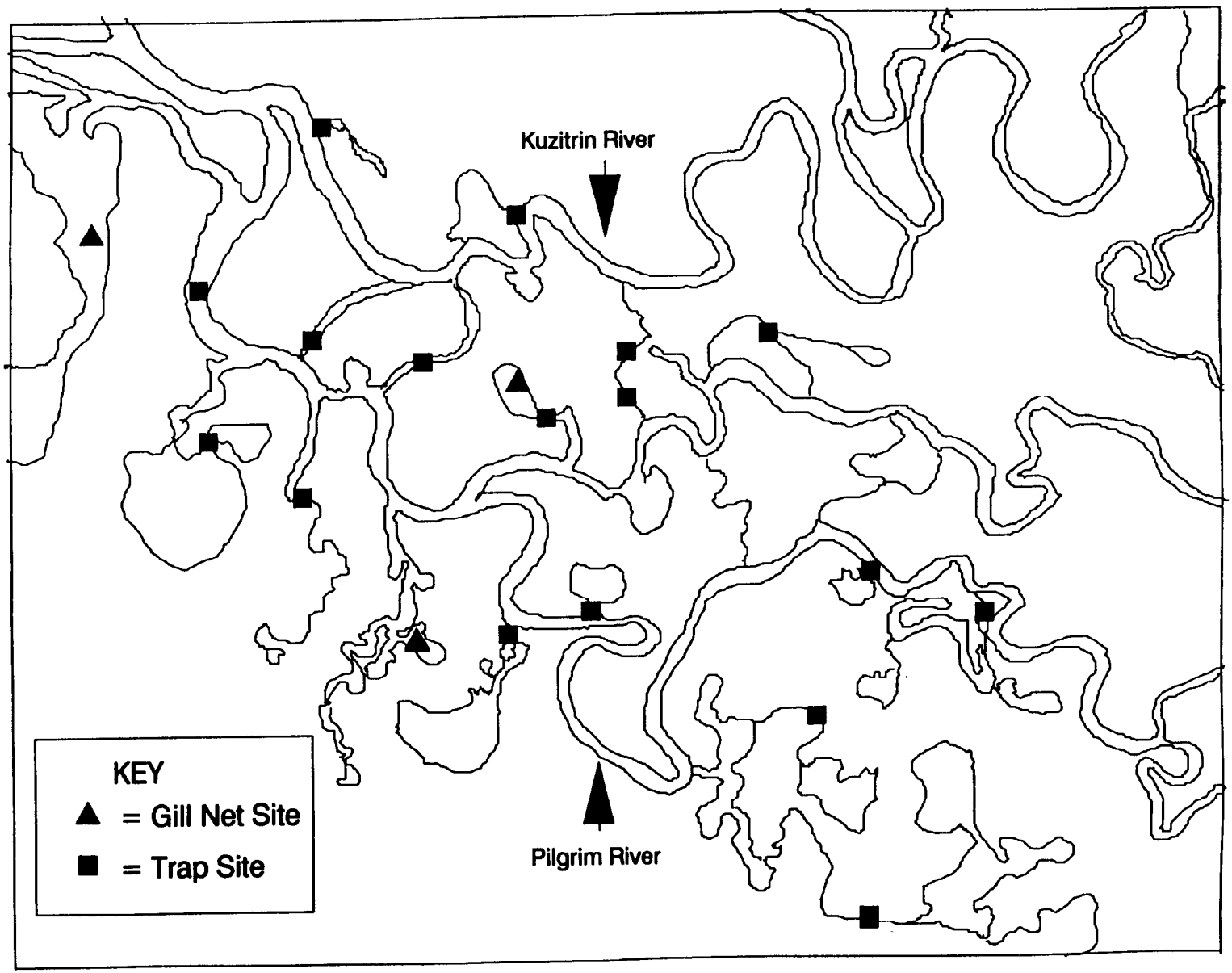

Figure 3. Sampling sites in the Pilgrim/Kuzitrin rivers study area during sampling event 1 (June 27 - July 3, 1992), event 2 (July 7 - 17, 1992), and event 3 (June 17 - 28, 1993)

Table 1. Description of gear used to capture northern pike in the Pilgrim/Kuzitrin study area, 1992 and 1993.

Gear Type	Description
Traps:	
1) Hoop Traps	1 m diameter by 4 m long with 25 mm square mesh nylon netting on 7 fiberglass hoops and with finger-style throats on second and fourth hoops. Attached leads and wings were of various depths from 2.4 m to 3.6 m with mesh sizes of 10 or 25 mm.
Gill Nets:	
1) Six panel (floating and sinking)	46 m long with 7.6 m panels of 25, 38, 51, 25 38, and 51 mm bar mesh multifilament netting.

only for northern pike extruding sexual products. At least three scales were taken from the preferred zone adjacent to, but not on the lateral line, above the pelvic fins as described by Williams (1955). Previous analysis (Peckham and Bernard 1987) indicated ages as determined from scales, sagittal otoliths, and cleithra were similar. Scales were directly mounted onto gum cards. Gum cards were used to make impressions on 20-mil acetate using a Carver press at 137,895 kPa (20,000 psi) heated to 93^{0}C for 30 s. Annuli were counted along their dorsal radius using a Micron 770 Microfiche reader. All data was recorded onto tagging length mark-sense forms (Version 1.0).

Data Analysis

Abundance Estimation:

The Jolly-Seber model (Jolly 1965, Seber 1965) was used for estimating the abundance of northern pike near the confluence of the Pilgrim and Kuzitrin rivers in July 1992. The assumptions necessary for accurate estimation of abundance with the Jolly-Seber model are paraphrased as follows (after Seber 1982):

1) every fish in the population has the same probability of capture in the *i*th sample;

2) every marked fish has the same probability of surviving from the *i*th to the (i + 1) sample and being in the population at the time of the i + 1 sample;

3) every fish caught in the *i*th sample has the same probability of being returned to the population;

4) marked fish do not lose their marks between sampling events and all marks are reported on recovery; and,

5) all samples are instantaneous (sampling time is negligible).

The first assumption is valid if every fish in the population had an equal probability of being sampled during all three events. This assumption was examined by testing for size-selective sampling. The cumulative length frequency distributions of all three events were examined with an Anderson-Darling test (Scholz and Stephens 1987). Also, because events one and two were so close together, a chi-square test was used to test if the probability of recapture was the same for fish marked in both rivers. Since a year passed between events two and three it is assumed that the fish would have mixed completely between those events.

Assumptions 2 and 3 were assumed to be valid because the number of fish $\geq$ 300 mm killed while sampling, or released alive without a tag, was less than 4%. Assumption 4 was met by double marking of northern pike with Floy tags and partial finclips. Assumption 5 was met by restricting each sampling event

to 12 days or less, and it is believed that additions and losses to and from the population during each event were negligible.

The Jolly-Seber procedures for estimating abundance for July 1992 were obtained by first calculating the number of northern pike marked in the population just prior to the 1992B sample ($\hat{M}_{1992B}$):

$$\hat{M}_{1992B} = \frac{R_{1992B}\, z_{1992B}}{r_{1992B}} + m_{1992B} \qquad (1)$$

where: R_{1992B} = the number of marked northern pike released after the 1992B sample;

z_{1992B} = the number of different northern pike caught before the 1992B sample, not seen during the 1992B sample, but subsequently recaptured in the 1993 sample;

r_{1992B} = the number of northern pike recaptured in 1993 that were released in the 1992B sample (recaptures from R_{1992B}); and,

m_{1992B} = the number of marked northern pike caught during the 1992B sample (recaptures from 1992A).

With estimates of M_{1992B}, survival rate was calculated from the relation of those surviving to 1992B from those initially marked and released in 1992A:

$$\hat{\phi}_{1992A\text{-}1992B} = \frac{\hat{M}_{1992B}}{R_{1992A}} \qquad (2)$$

where: R_{1992A} = the number of marked northern pike released after the 1992A sample.

Abundance was then calculated by substituting the estimated number of marked fish alive for the number of marked fish released in a standard Petersen estimate:

$$\hat{N}_{1992B} = \frac{\hat{M}_{1992B}\, n_{1992B}}{m_{1992B}} \qquad (3)$$

where: n_{1992B} = the number of northern pike caught during the 1992B sample.

The abundance estimate and the variance was calculated using the program JOLLY (Pollock et al. 1990).

Composition Estimation:

After a review of Gabelhouse (1984), categories of Relative Stock Density were defined as follows: "stock" size, 300 to 524 mm (FL); "quality" size, 525 to 654 mm; "preferred" size, 655 to 859 mm; "memorable" size, 860 to 1,079 mm; and "trophy" size, 1,080 mm and longer.

The proportions and associated variances of the northern pike of each age and length category were estimated with the following formulas from Cochran (1977):

$$\hat{p}_j = n_j/n \text{ , and} \tag{4}$$

$$V[\hat{p}_j] = \frac{\hat{p}_j(1 - \hat{p}_j)}{n - 1} \tag{5}$$

where:

n = the number of fish sampled to estimate length or age composition;

n_j = the number of sampled fish in length or age group j; and

$\hat{p}_j$ = the estimated fraction of the fish in length or age group j.

The estimated abundance of northern pike by group was calculated as:

$$\hat{N}_j = \hat{p}_j \hat{N} \tag{6}$$

The variance for $\hat{N}_j$ is a sum of the exact variance of a product from Goodman (1960):

$$V[\hat{N}_j] = V[\hat{p}_j]N^2 + V[\hat{N}]\hat{p}_j^2 - V[\hat{p}_j]V[\hat{N}]) \tag{7}$$

RESULTS

During the first event 577 northern pike were captured and lengths from 575 fish were obtained (Figure 4). Of these fish 546 were marked and released. During the second event 961 northern pike were captured and examined for marks, and 959 fish were measured (Figure 4). Forty-nine of these fish had been marked during the first event. A total of 826 newly captured northern pike were marked and released during event two. Of the fish marked during events one and two, 97.5% were captured using traps, and only 34 fish (2.5%) were captured with gill nets. During the third event 2,281

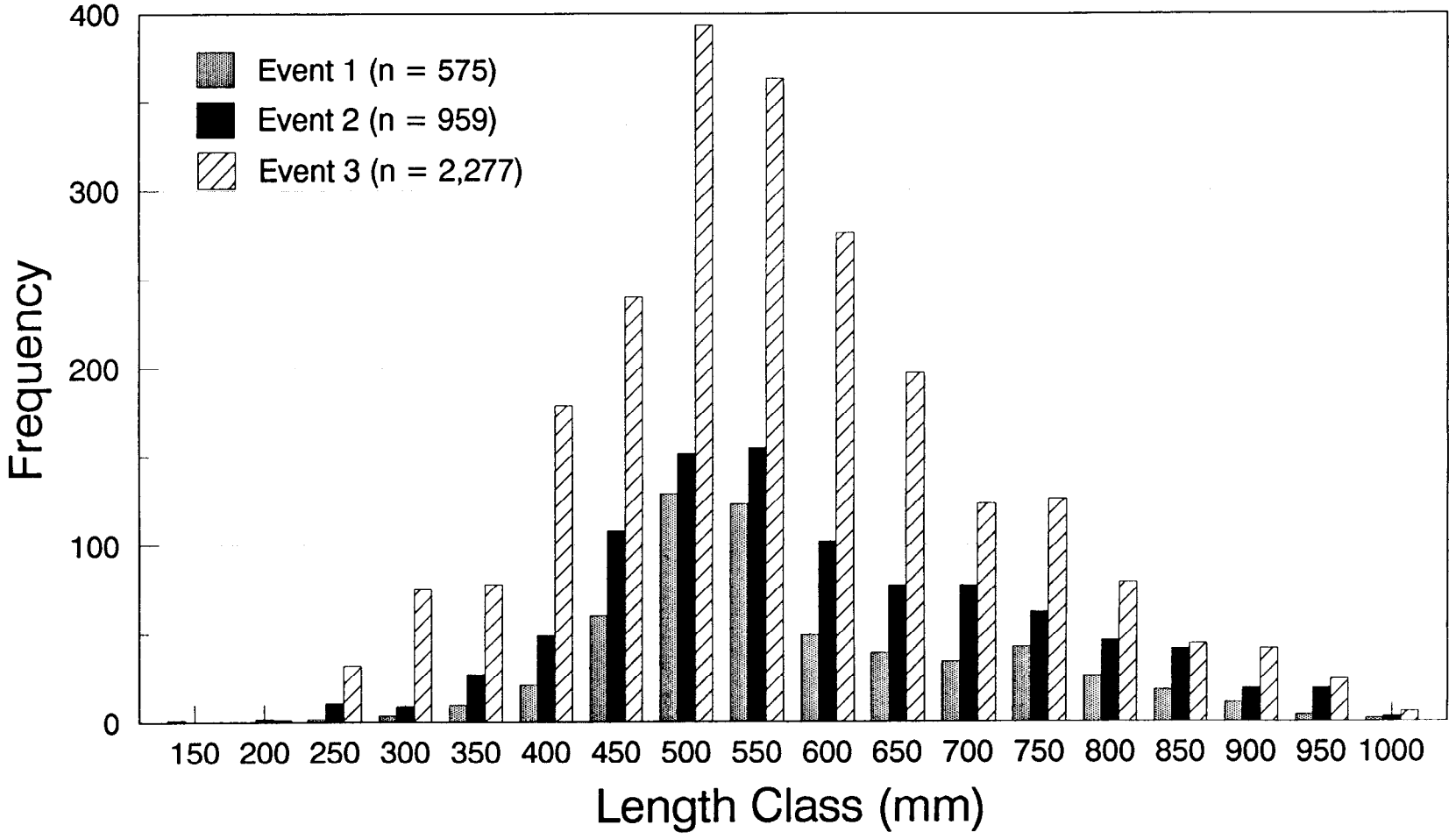

Figure 4. Length frequency of northern pike captured in the Pilgrim/Kuzitrin study area during sampling event 1 (June 27 - July 3, 1992), event 2 (July 7 - 17, 1992), and event 3 (June 17 - 28, 1993).

northern pike were captured and lengths from 2,277 fish were obtained (Figure 4). Of these fish, 1,871 were captured for the first time during the experiment and 188 had been marked during the first and second sampling events. All fish captured during the third event were captured in traps. Throughout the experiment 176 sampling-related mortalities (4.6%) occurred. For northern pike ≥ 300 mm 145 sampling-related mortalities (3.8%) occurred. It was assumed that spawning had taken place prior to all sampling events because no sex products were extruded. Therefore, sex was not determined for the fish sampled.

Test of Assumptions for Abundance Estimator

Although a significant difference in length distributions for northern pike caught during sampling events one, two, and three was detected using the Anderson-Darling k-sample test (T_{akn} = 21.69 and $P < 0.01$), by inspecting the cumulative length frequency plot (Figure 5) it was concluded that these length distributions were not biologically different. In addition no significant difference was detected (χ^2, df = 1, P = 0.32, Table 2) between probabilities of recapture during the second event for northern pike marked in the Pilgrim and Kuzitrin rivers during the first event indicating equal probability of capture during the second event.

Abundance Estimate

Based on the above tests, the Jolly-Seber model (Jolly 1965, Seber 1965) was used for estimating the abundance of northern pike near the confluence of the Pilgrim and Kuzitrin rivers in July 1992. The estimated abundance of northern pike ≥ 300 mm in the study area was 10,828 fish (SE = 2,019).

Tag Loss

No tag loss was observed during 1992 (sampling events one and two). However six fish marked in 1992 and recaptured in 1993 had lost their tags. Since fish had been double marked in 1992, fish that had lost their tags were easily identified in 1993.

Length Composition

No trophy size northern pike were captured. For northern pike ≥ 300 mm, 27% were stock size, 39% were quality size, 26% were preferred size, and 7% were memorable size (Table 3).

Age Error

Scales from 151 northern pike caught in 1992 and recaptured in 1993 were examined for bias in aging. Only 7% of the fish caught in 1992 were aged as one year older in 1993. The majority of the fish (93%) were incorrectly aged (Table 4). The error in aging was greatly skewed towards younger age

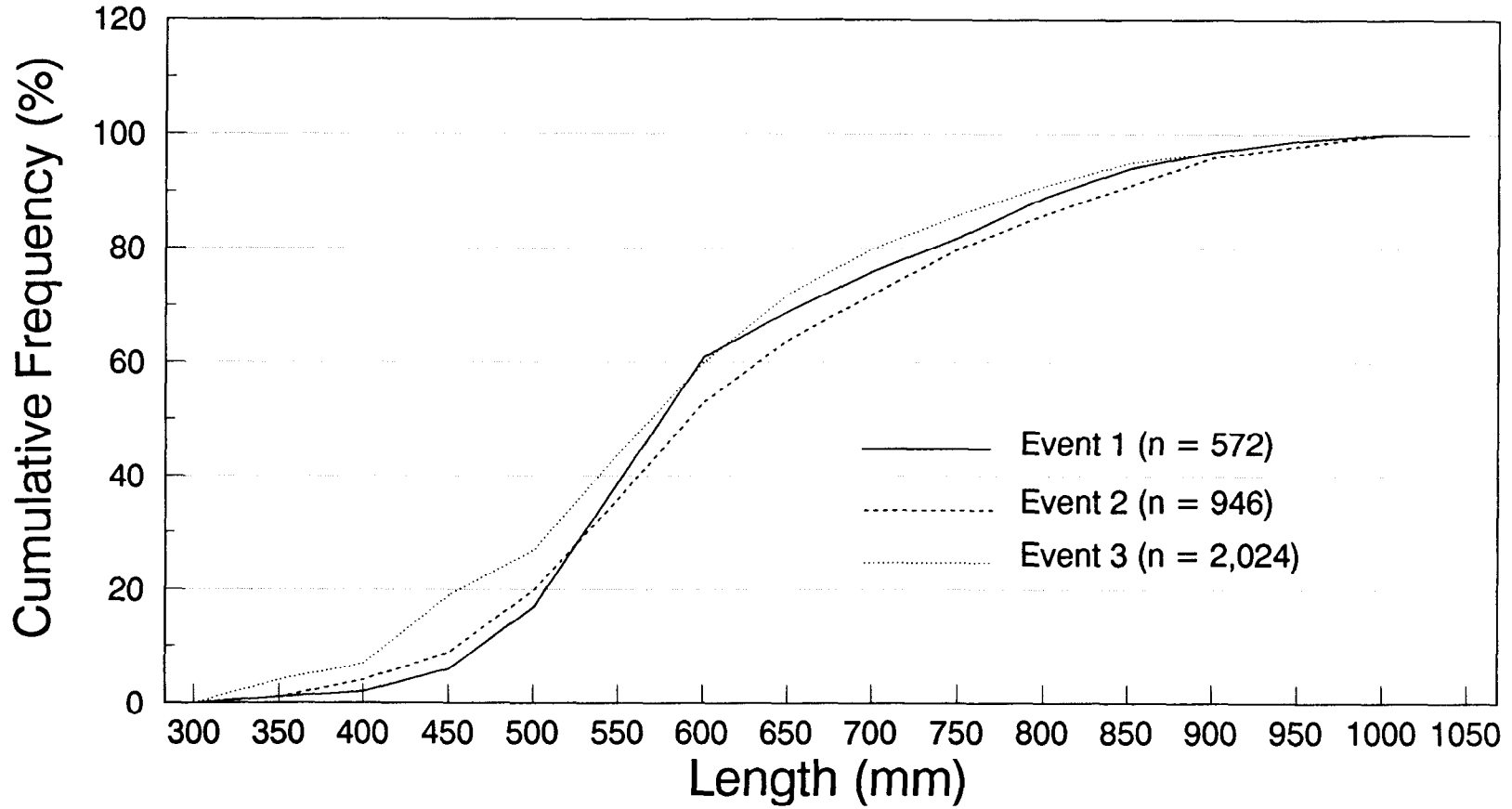

Figure 5. Cumulative length frequency for northern pike (≥ 300 mm) captured in the Pilgrim/Kuzitrin study area during sampling event 1 (June 27 - July 3, 1992), event 2 (July 7 - 17, 1992), and event 3 (June 17 - 28, 1993).

Table 2. Contingency table[a] used to test the hypothesis that the probability of recapture during the second event (July 7-17, 1992) was the same for northern pike marked in the Pilgrim/Kuzitrin study area during the first event (July 27-July 3, 1992).

River where fish were marked during Event 1	Event 2	
	Not Recaptured	Recaptured
Pilgrim	352	38
Kuzitrin	145	11

[a] $\chi^2 = 0.99$, df = 1, and P = 0.32

Table 3. Estimated percentage and abundance of northern pike (≥ 300 mm) in the Pilgrim/Kuzitrin study area, July 1992, by Relative Stock Density category.

Category	Gabelhouse Minimum Length (mm)	Relative Stock Density[a]	SE	Abundance	SE
Stock	300	27	1.1	2,926	559
Quality	525	39	1.3	4,268	807
Preferred	655	26	1.1	2,862	547
Memorable	860	7	0.7	771	160
Trophy	1,080	0	0.0	0	0
Total		100		10,828	

[a] Relative Stock Density expressed as a percentage with categories from Gabelhouse (1984).

Table 4. Aging error[a] for northern pike marked in 1992 and recaptured in 1993 in the Pilgrim/Kuzitrin study area.

Error (Years)	Sample Size	Proportion	Standard Error
-6	6	0.040	0.016
-5	14	0.093	0.024
-4	21	0.139	0.028
-3	29	0.192	0.032
-2	47	0.311	0.038
-1	18	0.119	0.026
0	11	0.073	0.021
1	4	0.026	0.013
2	1	0.007	0.007
Totals	151	1.000	

[a] 1993 age - (1992 age + 1). If a fish was age 9 in 1993 and the same fish was age 12 in 1992 the age error would be -4 years.

estimates. This pronounced error in aging northern pike sampled in the Pilgrim/Kuzitrin study area precluded the estimation of age composition.

DISCUSSION

The average sport harvest of northern pike from the Pilgrim River between 1988 and 1992 was 508 fish (Mills 1989 - 1993). An estimated 381 northern pike were harvested from the Kuzitrin River by the sport fishery in 1991 (Mills 1992). This is the only estimate available for the Kuzitrin River. Anecdotal evidence suggests that the reported sport harvest of northern pike from the Pilgrim River may be a combination of fish caught in the Pilgrim and Kuzitrin rivers. Anglers interviewed in the study area indicated that they fish for northern pike in both rivers during the course of a fishing trip.

Analysis by ADF&G staff has indicated that northern pike in Interior Alaska can sustain average exploitation rates of 16% (see Pearse and Hansen 1993). If this exploitation guideline is applicable to northern pike population(s) in the Pilgrim and Kuzitrin rivers, current harvests of northern pike by the sport fishery appear to be sustainable, especially when considering that abundance (10,828) of northern pike in this study applies only to a relatively small portion of Pilgrim and Kuzitrin rivers. Obviously this is contingent on the subsistence harvest which is currently unknown.

Inaccuracy in aging northern pike scales has been found in other northern pike populations in Alaska (Pearse and Hansen 1992). However, the error in aging northern pike from the Pilgrim/Kuzitrin study area is more pronounced than observed elsewhere. The same scale reader was responsible for aging northern pike sampled in 1992 and 1993, so error in age determination was most likely due to difficulty in distinguishing annuli.

ACKNOWLEDGMENTS

The author thanks Matt Evenson, Fred DeCicco, Kirk Rose, and Nick Hughes for assistance with the field work. The author is grateful to Dave Bernard, Pat Hansen, and Peggy Merritt for various aspects of planning and reporting. Thanks to Sara Case for helping in preparing the manuscript for publication.

LITERATURE CITED

Burkholder, A. 1993. Abundance and length-age composition of northern pike near the confluence of the Pilgrim and Kuzitrin rivers, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-16, Anchorage.

Casselman, J. M. 1974. External sex determination of northern pike, *Esox lucius Linnaeus*. Transactions of the American Fisheries Society. 103(2): 343-347.

LITERATURE CITED (Continued)

Cochran. W. G. 1977. Sampling techniques, 3rd ed. John Wiley & Sons, Inc. New York.

Gabelhouse, D. W. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4: 273-285.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55: 708-713.

Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigration-stochastic model. Biometrika 52: 225-247.

Mills, M. J. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-I-A).

_____. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-I-A).

_____. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1985-86, Project F-10-1, 27(RT).

_____. 1987. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game. Fishery Data Series No. 2, Juneau.

_____. 1988. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game. Fishery Data Series No. 52, Juneau.

_____. 1989. Alaska statewide sport fisheries harvest report. Alaska department of Fish and Game, Fisheries Data Series No. 122, Juneau.

_____. 1990. Harvest and participation in Alaska in sport fisheries during 1989. Alaska department of Fish and Game, Fisheries Data Series No. 90-44, Anchorage.

_____. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

_____. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage.

_____. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage.

Pearse G. A. and P. A. Hansen. 1992. Evaluations of age determination in Alaskan northern pike. Alaska Department of Fish and Game, Fishery Data Series No. 92-4, Anchorage.

_____. 1993. Estimates of sustainable yield for the northern pike populations in George, Volkmar, T, and Harding lakes. Alaska Department of Fish and Game, Fishery Manuscript No. 93-1, Anchorage.

Peckham, R. D. and D. R. Bernard. 1987. Northern pike abundance and composition study. Alaska Department of Fish and Game, Fishery Data Series No. 27, Juneau.

Pollock, K. H., J. D. Nichols, C. Brownie, and J. E. Hines. 1990. Statistical inference for capture-recapture experiments. Wildlife Monographs 107: 1-97.

Seber, G. A. F. 1965. A note on the multiple recapture census. Biometrica 52: 249-259.

_____. 1982. The estimation of animal abundance and related parameters. 2nd ed. Charles Griffin and Company Limited, Charles Griffin House, Crendon Street, High Wycombe Bucks, HP13 6LE, England.

Scholz, F. and Stephens. 1987. K-Sample Anderson-Darling tests. Journal of the American Statistical Association 82: 918-924.

Williams, J. E. 1955. Determination of age from the scales of northern pike (Esox Lucius L.). Ph. D. Thesis. University of Michigan.